NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE SPECIFICATION

FENCE (FEET)

CODE 382

BARBED AND SMOOTH WIRE

SCOPE: This specification provides guidance for the installation of permanent barbed and smooth wire fences. Fencing includes all components required for achieving the objectives of the practice and meeting site conditions.

TYPE OF FENCES

POST AND WIRE FENCE

Post and wire fences are suitable as permanent fence in areas that receive moderate to heavy pressure by livestock. Barbed wire is the most common fence built for cattle. Smooth wire is generally considered safer for horses and llamas.

HIGH TENSILE WIRE FENCE (NON-ELECTRIFIED)

High tensile post and wire fences are suitable for areas that receive moderate to heavy pressure by livestock.

LET-DOWN FENCE

The let-down fence is typically a barbed-wire fence that can be laid on the ground during winter after the grazing season or during periods of expected big game movement, but remains under tension at all other times. This fence design is suited for use where seasonal movements of big game must be accommodated, or where wildlife pressure on fences is high. Let-down fences are designed for mountainous areas with heavy snow pack that can loosen or break fence wires and pull over fence posts.

Although let-down fences greatly reduce fence damage from snow or wildlife, several disadvantages of this fence design shall be noted:

1. Cannot protect against stray or trespass livestock when fence is down;

2. Must be raised and lowered each year; and,

3. Over-winter contact with the ground corrodes fence wire more quickly.

LINE POSTS

Wooden posts are preferred for use in high snowfall areas because of their extra strength. Steel line posts can be used in moderate to low snowfall areas, or in rocky areas where posts must be pounded or drilled to be set.

TABLE 1. Line Post Requirements for Barbed and Smooth Wire Fence

Wood posts do not need to be new materials (Railroad Ties and Power Poles are adequate); however, all posts shall meet the minimum criteria for durability and protective coating. Wood posts need to be sound and free from decay, with all limbs trimmed substantially flush with the body. Post shall be sufficient length to meet buried depth, fence height requirement plus 2 inches. Lengths listed below are based on a 42-inch top wire height.				
LINE POST TYPE	**MINIMUM DIAMETER**	**MINIMUM SETTING DEPTHS**	**MINIMUM LENGTHS**	**MINIMUM PROTECTIVE COATING, OTHER**
Wood-juniper, cedar	3-1/2 inches	24 inches	6 feet	None
Wood other than above	3-1/2 inches	24 inches	6 feet	Complete penetration of the sapwood with approved treatment materials. Pressure-treated, entire length of post. See note below.
Standard "T" or "U" section steel rolled with high carbon steel and studded, embossed, or punched for wire attachment with anchor plate.	1.25 pounds per foot of length, exclusive of anchor plates	16 inches Top of the spade + 1 knob – minimum of 16”	5.0 feet	Hot-dip galvanized, or one or more coats of high-grade, weather-resistant steel paint, or enamel-applied and baked.
Live trees	6 inches at top wire	Wire not wrapped or stapled directly to tree. A wood slat is nailed to the side of the tree and the wires stapled to the slat.		

NOTE: Chromated Copper Arsenate (CCA)-treated wood posts should not be used where treated wood may come into contact with water sources (wetlands, streams, high water tables, etc.). Other chemically-treated and pressure-treated wood posts may be used in these areas. (EPA 2002)

LINE POST SPACING

Spacing is the same for all line post materials.

TABLE 2. Line Post and Stay Spacing

FENCE TYPE	LINE POST SPACING (MAXIMUM INTERVAL)
3-Wire Fence	16-1/2 feet (1 rod) without stays 20-foot with one stay mid-way between posts
4-Wire Fence or more	20-foot without stays 25-foot with one stay set mid-way between line posts 30-foot with two stays set at equal intervals between posts
3-Wire or 4-Wire Suspension Fence	80 to 100 feet (not to exceed 100 feet). Stays shall be spaced not to exceed 16-1/2 feet (1 rod) in the line.
Bison fence	18 foot with 2 stays placed at equal distance.
Heavy Snow Country and Let-Down Fences	16-1/2 feet (1 rod) between wooden posts – wood/fiberglass stays at approximately 4-foot intervals.

WIRE

TABLE 3. Wire Type Requirements for Barbed and Smooth Wire Fence

WIRE TYPE	MINIMUM WIRE SIZE	MINIMUM PROTECTIVE COATING	STRAND-BREAKING STRENGTHS
Standard Double Strand Barbed Wire	12-1/2 gauge with 14 gauge or heavier two-point barbs spaced not more than 5 inches apart.	Class I galvanized per ASTM-121	950 pounds or 70,000 psi
High-Tensile Double Strand Barbed Wire	15-1/2 gauge	Class III galvanized per ASTM-854	1,400 pounds or 135,000 psi
Standard Smooth Double Strand Wire	12-1/2 gauge	Class I galvanized per ASTM-121	950 pounds or 70,000 psi
Standard Smooth Single Strand	9 gauge	Class I galvanized per ASTM-121	950 pounds or 70,000 psi
High-Tensile Single Strand Smooth	12-1/2 gauge	Class III galvanized per ASTM-854	1,400 pounds or 135,000 psi

TABLE 4. Stay Requirements

STAY TYPE	MINIMUM DIAMETER/WEIGHT	MINIMUM LENGTH
Wood Preferred in high snow areas	2.5 inches diameter	Fence wire height + 2 inches
Wire	9-1/2 gauge twisted, manufactured for this purpose; galvanized-zinc coated	4 inches + distance between bottom and top wire
Fiberglass	Especially fabricated for this purpose	Fence wire height + 2 inches

BRACE AND ANCHOR POSTS (WHERE WIRE IS TIED OFF)

Posts must be of sufficient length to meet fence height, setting depth requirements, plus 6 inches.

TABLE 5. Brace Post Requirements for Barbed and Smooth Wire Fence

Posts need not be new materials, (Railroad Ties and Power Poles are adequate); however, all posts shall meet the minimum criteria for durability and protective coating and be sound and free from decay, with all limbs trimmed substantially flush with the body. Lengths listed below are based on a 42-inch top wire height. Steel pipe needs to be free from corrosion and pitting.

BRACE POST TYPE	MINIMUM DIAMETER/WEIGHT	MINIMUM SETTING DEPTHS	MINIMUM LENGTHS	OTHER
Wood-juniper, cedar	5 inches Use 6” diameter post if fence is over 6 feet tall.	3 feet	7 feet	None
Wood-pine or similar woods	5 inches Use 6” diameter post if fence is over 6 feet tall.	3 feet	7 feet	Complete penetration of the sapwood with approved treatment materials. Pressure-treated, entire length of post (see Note).
Steel, round	2-3/8 inches outside diameter (OD), 3.65 lb./ft. or equivalent.	3 feet – set in 12" diameter concrete. No concrete needed if welded to compression brace.	7 feet	Schedule 40 pipe will meet these requirements.

Table 5 continued on next page.

TABLE 5 (CONTINUED). Brace Post Requirements for Barbed and Smooth Wire Fence

Posts need not be new materials, (Railroad Ties and Power Poles are adequate); however, all posts shall meet the minimum criteria for durability and protective coating and be sound and free from decay, with all limbs trimmed substantially flush with the body. Lengths listed below are based on a 42-inch top wire height. Steel pipe needs to be free from corrosion and pitting.				
BRACE POST TYPE	**MINIMUM DIAMETER/WEIGHT**	**MINIMUM SETTING DEPTHS**	**MINIMUM LENGTHS**	**OTHER**
Steel, angle iron	2.5 inches x 2.5 inches x 0.25 inch	Anchor post - 3 feet set in 12-inch diameter concrete. Diagonal set in concrete 18” x 18” x 12”.	7 feet	
Concrete	10" x 10" with four #4 bars, Grade 60	4.5 feet	8.5 feet	See Figure 1.
Live trees	10 inches at top wire	Wire not wrapped or stapled directly to tree. Several wood slats spaced around the tree trunk provide protection if wire is wrapped around the tree. Staple wire to slats.		

NOTE: Chromated Copper Arsenate (CCA)-treated wood posts should not be used where treated wood may come into contact with water sources (wetlands, streams, high water tables, etc.). Other chemically-treated and pressure-treated wood posts may be used in these areas. (EPA 2002)

CONCRETE BRACE AND CORNER POSTS

Reinforced concrete posts may be used in any acceptable field conditions, but are specifically recommended in areas where the soils are corrosive or highly corrosive (when ECe $\geq$ 8 mmhos/cm). They can be used as line posts, corner posts (with bracing described below), or as brace posts without brace members (stand alone post).

All concrete posts shall use 3,000 psi air-entrained concrete and shall be reinforced with a minimum of four #4 grade 60 rebar that run the length of the post minus 3 inches at top and bottom (e.g., 8.0-foot rebar length in a 8.5-foot long post). Each rebar shall be located 2.5 inches from the nearest outside edges of the post. The posts shall be a minimum of 10-inch x 10-inch diameter for the entire length of the post (see Figure 1).

REBAR REINFORCEMENT IN CONCRETE POSTS

Bracing of concrete corner posts shall be accomplished using a minimum of 2 anchor wires, double wrapped, connected to the concrete post 6 inches from the top of the post and connected to a buried deadman. The deadman shall be rigid, with minimum diameter of 12 inches, set into the ground at a minimum of a 4-foot depth. Earth backfill on top of the deadman shall be thoroughly tamped in layers not thicker that 4 inches and shall completely fill the hole to the ground surface. Connect the anchor wires to the deadman in approximately a 45-degree angle from the post (resulting in deadman location being approximately 4.5 feet away from the post). To improve the visibility and service life of the anchor wire, PVC or HDPE pipe should be slit lengthwise and slipped over the wire throughout its exposed length.

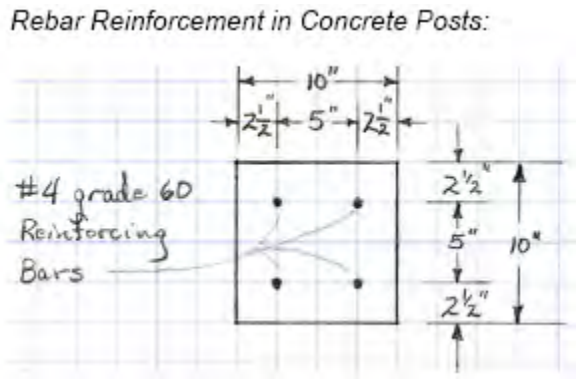

Figure 1. Rebar Reinforcement in Concrete Posts

POST DEPTH

All posts shall be placed to the required depth and shall be firmly embedded. Posts shall be set to the minimum depths listed in **TABLE 1–Line Post Requirements** or **TABLE 5–Brace Post Requirements.**

Wood posts shall be driven or set in holes and backfilled with compacted earth or poured concrete. Earth backfill around posts shall be thoroughly tamped in layers not thicker than 4 inches and shall completely fill the posthole to the ground surface. Concrete backfill around posts shall be rodded into place in layers not thicker than 12 inches and shall completely fill the posthole to ground surface. Backfill, either earth or concrete shall be crowned up around posts at the ground surface.

Steel line posts shall be driven solidly into the ground until the plate is covered plus 1 knob, minimum of 16 inches. If soil conditions prevent firmly settling line posts in the ground, Jack-leg (bucks), or wire cribs may be used.

BRACING AND ALIGNMENT

Braces are required at all corners, gates and definite angles (horizontal and vertical) greater than 15 degrees. Sound wood posts a minimum of 4 inches in diameter, buried 2.5 feet, spaced no more than 12 feet apart are adequate for gentle turns less than 15 degrees.

There is no maximum distance between brace spacing as long as means are available to stretch wires. A single 6-inch diameter brace post, buried 3 feet, spaced no greater than 1/4-mile apart is sufficient to stretch the wire. It is recommended not to exceed 1/2-mile between gates (braces) for ease of management.

Required brace types include the Standard H-brace, the Diagonal brace, or concrete reinforced.

- Less than or equal to 90 degree corners – 3 post brace – horizontal or diagonal
- Greater than 90 degree corner – 4 post brace, double H or double diagonal
- Rock Cribs – (Min. 4.5’ x 4.5’ x 4.5’)
- Rock jack
- Jack leg brace – wet, shallow, etc., (Jack and wire fences require conventional bracing and/or the use of deadman.
- If using deadman alternatives – use caution as it relates to trapping livestock and wildlife as well as possible other safety issues. Placing a “split” PVC pipe over wires to make more visible.

See PDF drawings for corner and in-line bracing alternatives at:
http://www.mt.nrcs.usda.gov/technical/eng/drawings.html

HORIZONTAL BRACES

Horizontal brace members (compression braces) shall be at least 6 feet in length and notched into the top half of the brace post and anchor post, at a minimum of 36 inches above ground level and below the top 6 inches of the brace and anchor post. Fences taller than 4 feet – the brace member will be in the top 1/3 of the post no closer than 6 inches from the top of the post. Steel dowels, spike, etc., can be used, rather than notching, to attach brace between anchor post and brace post.

TABLE 6. Brace Member (Compression) Requirements for Barbed and Smooth Wire Fence

BRACE MEMBER TYPE	MINIMUM DIAMETER/WEIGHT	MINIMUM LENGTH	OTHER
Wood, horizontal	3.5 inches	6 feet	Juniper, cedar, no treatment needed. All others pressure-treated, entire length of post.
Wood, diagonal	3.5 inches	8 feet	Juniper, cedar, no treatment needed. All others pressure-treated, entire length of post.
Steel, round, horizontal, pipe or tubular steel	2 inches OD, 2.25 lb./ft. or equivalent	6 feet	None
Steel, round, diagonal, pipe or tubular steel	2 inches OD, 2.25 lb./ft. or equivalent	8 feet	None
Steel, angle iron, diagonal (when used with and all metal brace system)	2 inches x 2 inches x 0.25-inch	8 feet	None

Note: Brace member (horizontal) will be a minimum of 1 foot longer than the anchor post is high above the ground surface, minimum of 6 feet. An 8-foot tall post (above ground) on a deer fence will require a 9-foot horizontal brace. The corresponding diagonal brace length will be a minimum of 1.3 times the length of what the horizontal brace would have been (9 feet x 1.3 = 12 feet).

BRACING WIRE

Brace wires (or guy wires) shall be formed from two complete loops of:

1. No. 9 gauge smooth wire, single strand;

2. No. 12-1/2 gauge double-strand smooth or barbed wire.

3. A single strand - No. 12-1/2 gauge high-tensile smooth wire.

Brace wires shall extend from a point approximately 2 inches below the top of the brace post to as close to ground level as possible on the anchor post. Never have the brace wire on the brace post higher than the top of the anchor post or it will pull the anchor post up to that level (see Figure 2). The brace wires shall be double-wrapped (single for high tensile) around each post, stapled and spliced together. A stick, pipe, etc., about 18 to 24 inches long, is placed mid-way along the brace wires, and all four wires are twisted together so the brace wires tightly secure the compression brace and provide needed rigidity. An in-line strainer can be used for high-tensile wire in lieu of twisting wires.

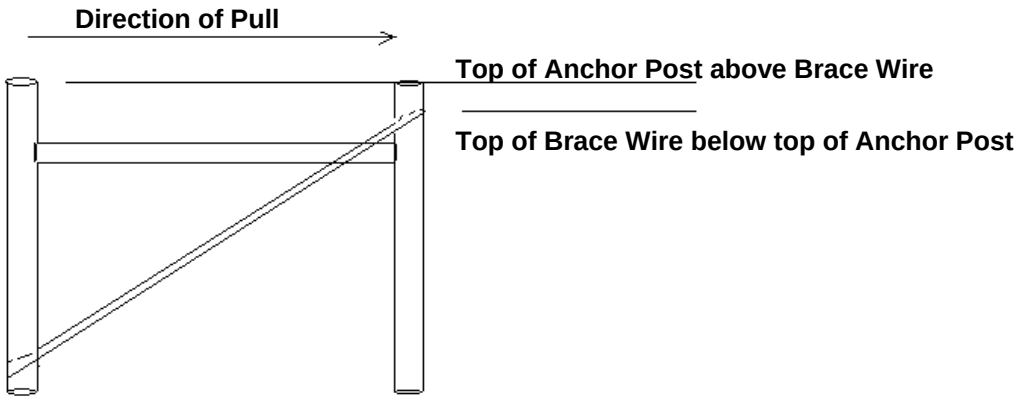

Figure 2. This picture is showing brace wire height in relation to top of anchor posts.

DIAGONAL BRACES

The top end of wooden diagonal brace members shall be notched into the post being braced (anchor post) approximately 6 inches below the top of the post. Secure the brace member to the bottom brace post as well to prevent sideways movement. Steel dowels, spike, etc., can be used, rather than notching, to attach diagonal brace member between anchor post and brace post. In lieu of a buried brace, the diagonal compression brace will rest on a rock, disk or other sound structure a minimum of 1 foot square that is capable of preventing the brace from contacting the soil surface.

Brace wires shall extend from a point above the ground level of the anchor post to a similar point on the diagonal brace member. The brace wires shall be double-wrapped around anchor post and the compression brace post. A twist stick, pipe, or metal rod, about 18 to 24 inches long, is placed mid-way along the brace wires, and all four wires are twisted together so the brace member is tightly secured. An in-line strainer can be used for high tensile wire in lieu of twisting wires.

TABLE 7. Rock-Jacks Used as Brace Posts

ROCK-JACK COMPONENTS	MINIMUM DIMENSIONS	LENGTH
Anchor Post	4 inches x 4 inches dimensional-treated lumber or 5 inches diameter post	4.5 feet
Diagonal Braces (legs)	2 inches x 6 inches dimensional-treated lumber or 4-inch round posts or 5-inch split poles	9 feet
Ground Piece	2 inches x 6 inches dimensional-treated lumber or 4-inch round posts or 5-inch split poles	8 feet
Flooring	2 inches x 6 inches dimensional-treated lumber	6 feet , 5.5 feet, 5 feet, and 4.5 feet, 4 feet, 3.5 feet, 3 feet and 2.5 feet

NOTE: Chromated Copper Arsenate (CCA)-treated wood posts should not be used where treated wood may come into contact with water sources (wetlands, streams, high water tables, etc.). Other chemically-treated and pressure-treated wood posts may be used in these areas. (EPA 2002)

TABLE 8. Rock-Jacks Used as Fence Corners and Gates

ROCK JACK COMPONENTS	MINIMUM DIMENSIONS	LENGTH
Anchor Post	6 inches x 6 inches dimensional-treated lumber or 5-inch diameter post	4.5 feet
Diagonal Braces (legs)	2 inches x 6 inches dimensional-treated lumber, 4-inch round posts or 5-inch split poles	9 feet
Ground Piece	2 inches x 6 inches dimensional-treated lumber, 4-inch round posts or 5-inch split poles	8 feet
Flooring	2 inches x 6 inches dimensional-treated lumber	6 feet, 5.5 feet, 5 feet, 4.5 feet, 4 feet, 3.5 feet, 3 feet and 2.5 feet

NOTE: Chromated Copper Arsenate (CCA)-treated wood posts should not be used where treated wood may come into contact with water sources (wetlands, streams, high water tables, etc.). Other chemically-treated and pressure-treated wood posts may be used in these areas. (EPA 2002)

The anchor post is set on the ground.

The floor of the Rock-jack shall be constructed of 2-inch x 6-inch boards. Do not nail the platform down. Once the Rock-jack frame is constructed and the floorboards are in place, rocks are placed on the Rock-jack floor. Large rock weights will be placed at each joint with lesser-weight rock distributed evenly over the rock platform. Weight of rock on the platform is 2,000 pounds for a 3-wire fence and 2,700 pounds for a 4-wire fence. Line wires are stapled to the anchor post of the line Rock-jack.

FENCE HEIGHT and WIRE SPACING

Fence height is measured from the ground at post locations.

TABLE 9. Fence Height and Spacing Requirements

INTENDED USE	FENCE HEIGHT
Domestic livestock control with big game consideration.	Maximum height of 42 inches (+ or - 2 inches) for the top wire. Wire spacing of the top two line wires shall be a minimum of 10 inches apart at the post location. Bottom wire will be a minimum of 14 inches from the ground; 16 inches for antelope (see below for additional considerations for wildlife).
Domestic livestock control with big game consideration where the top wire exceeds 44 inches, but is not greater than 48 inches.	**If wire height exceeds 44 inches, the distance between the top wire and the second wire will be at least 12" and provisions must be made at identified crossings for wildlife movement; both over and under the fence.** These areas will not exceed 1/4-mile apart and there must be a minimum of one per fence. The fence in these designated crossing locations will not exceed 42 inches at the top wire and must include a minimum of one of the alternatives listed below to allow for wildlife movement (*see Common Alternatives below). Also see ***Special Use Only for a bison fence that exceeds the intended use.

***Common Alternatives.** (1. Smooth wire on top and/or bottom, top wire tied down between two posts, bottom wire tied up between two posts, 2. PVC on top wire for entire length between two posts; raise bottom wire in that stretch, lower top wire in that stretch, 3. Wood rail at top wire between two posts maximum 38 inches high (38-inch elk jump), 4. Cattle guard for antelope, 5. Extra stays so top and second wire will not cross, etc.). Minimum distance for chosen wildlife crossing is that distance between two posts or 1 rod (16.5 feet), whichever is greater.

See PDF drawings for corner and in-line bracing alternatives at:
http://www.mt.nrcs.usda.gov/technical/eng/drawings.html

COMMON WIRE SPACING

1. 3-Wire Cattle: 16”, 29”, 42”
2. 3-Wire Cattle: 14", 28", 42"
3. 4-Wire Cattle: 14", 22", 32”, 42"
4. 4-Wire Cattle with Antelope: 16", 24", 32", 42"
5. 5-Wire Sheep: 5", 11", 18", 26", 36" (need something for Antelope)**
6. 5-Wire Cattle and Sheep: 8", 16", 24", 32", 42"; or 5", 11", 18", 28", 42" (Need access for Antelope)**
7. 7-Wire Cattle and Sheep: 3”, 7”, 11”, 16”, 26”, 36”, 44” (Need access for Antelope)**
8. Deer exclosure: See power and/or woven wire fence
9. Elk: See power and/or woven wire fence
10. Bison: *** Special Use only -- 10”, 20”, 26”, 34”, 40”, 48”, 56”, 64” or 16”, 25”, 34”, 45”, 56”, 68” with Antelope present (See Power Fence for other alternatives).
11. Griz and Wolf Predator: See power and or woven wire fence.

****Sheep fences** should incorporate “cattle guards” designed for Antelope movement through the fence (see drawing at http://www.mt.nrcs.usda.gov/technical/eng/drawings.html); have gates no taller than 36 inches so Antelope can jump over or any other means to allow control of the sheep while allowing Antelope movement across fences. Young of year have the most difficulty jumping fences and/or jumping cattle guards. Leave gates open at the end of the grazing period to accommodate all Antelope movement.

SPECIAL CONSIDERATIONS FOR FENCES IN SAGE GROUSE HABITAT

- Fencing near leks (dancing grounds) will be avoided – no closer than 1,000 feet.
- Fences on the crest of low-lying hills may be a problem when located in high sage grouse use areas or near leks as grouse fly to display grounds before sunrise making them more vulnerable for collisions.
- Flat-topped wood posts provide raptor perch sites, consider having post with cone tops (purchase after market).
- Metal posts are preferable to wooden posts as the former discourages raptor perching.
- For segments of fence which are known to have grouse collisions, fence markers or tags that hang from the top wire may help grouse avoid the fence. PVC pipe strung through the top wire in one foot segments is an excellent alternative to flaggery.

SPLICING

When splicing of wire is necessary, use conventional wire-loop, "Western Union" splice or compression fittings.

Figure 3. Picture of a "Western Union" splice.

STAPLES AND FASTENER REQUIREMENTS

Staples shall be driven into the post at a 45-degree angle. Staples shall be driven just deep enough to snug the line wire without bending it.

TABLE 10. Staples and Fastener Requirements

U-shaped staple, conventional wire: No. 9 gauge galvanized wire or bright hard wire; at least 1 and 1/4-inch long.
L-shaped deformed shank staple: No. 9 gauge galvanized wire or bright hard wire; at least 1 and 1/4-inch long.
Fence wire shall be fastened to steel posts using steel clips manufactured for the purpose of attaching wires, or 9 gauge smooth wires.
Other post types will use fasteners and methods recommended by the manufacturer.

CROSSING DRAWS OR STREAMS

When the fence crosses landscape depressions, draws, or swales, and the bottom line wire is more than 20 inches above the ground at the low spot, the use of a deadman may be necessary to maintain fence height. When crossing the streams or very deep draws, the fence may be dead-ended on each side of the crossing by use of line braces. The section across the stream may be removable, a breakaway type, or swinging picket-type fence.

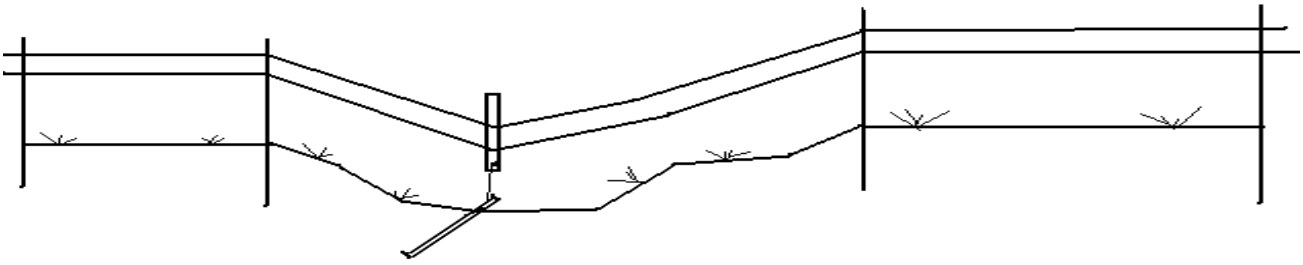

Figure 4. This illustration shows the use of a deadman when crossing a draw.